

### **Remarks**

Claims 11 - 21 are pending. Favorable reconsideration is respectfully solicited.

The claimed invention is directed to improved scratch resistant coatings. Improved scratch resistance is imparted through the incorporation of silica functionalized by reaction with an alkoxy-functional  $\alpha$ -silane also bearing an ethylenically unsaturated group.

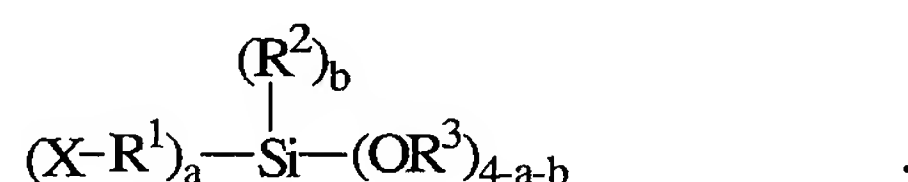
The claims have been rejected under 35 U.S.C. § 103(a) over Fukushima U.S. Patent No. 6,306,502 ("*Fukushima*"). Applicants respectfully traverse this rejection.

Improvement in scratch resistant coatings has been a continuing long felt need, and many different methods have been proposed to provide scratch resistance. For example, inorganic coatings deposited by CVD, plasma, or other methods have been proposed. Such coatings have been provided of silica, titania, silicon carbide, and even diamond. However, many substrates cannot be provided with such coatings due to the high temperatures or high energies involved in the coating process, and such coatings are generally inflexible and often brittle. Moreover, their coefficient of thermal expansion frequently does not match that of the substrate, and thus they may crack or spall off. Thus, abrasion resistant coatings with polymer matrices, which are more flexible and often have coefficients of expansion similar to the substrate, in particular polymer substrates, have long been used. However, polymers, even when highly crosslinked, tend to be relatively soft, and cannot by themselves provide a high degree of scratch resistance which is necessary for many applications.

*Fukushima* addresses the long felt need for improved abrasion resistant coatings having a polymer matrix, and in columns 1 and 2 discusses numerous prior art attempts to provide such coatings, and their deficiencies. The basic theme in the prior art discussed by *Fukushima* is incorporating organically modified silica into the polymer matrix. For example, this was done in the French et al. Patent U.S. 4,006,271, which issued long ago in 1977 (three decades ago).

*Fukushima* improved upon the prior art, not by changing the organically modified silica, but by including a urethane poly(meth)acrylate and a (meth)acrylate having an isocyanurate skeleton.

The modified silica disclosed by *Fukushima* is described at column 3, lines 12-32, and is silica conventionally reacted with a silane (or hydrolysate thereof) of the formula



In this formula,  $OR^3$  is an alkoxy group such as a methoxy or ethoxy group;  $R^2$  is a  $C_{1-8}$  alkyl group; X is acrylo, methacrylo, or vinyl; and  $R^1$  is an "alkylene" group with 0 to 8 carbon atoms, *i.e.* a covalent bond or a  $C_{1-8}$  alkylene group. Thus, the alkoxysilanes of *Fukushima* include such common silanes as vinyltrimethoxysilane, where the vinyl group is directly bonded to silicon, methacrylopropyltrimethoxysilane, used in all of *Fukushima's* examples and even 9-decenyltrimethoxysilane, where a 1-decenyl group is bonded directly to silicon.

At column 5, lines 7 - 20, a list of specific alkoxysilanes is given, and at column 5, lines 21 - 28, a list of preferred alkoxy silanes is provided. Notably, none of these is an alkoxy-functional  $\alpha$ -silane as used and claimed by Applicants.

Applicants have shown by their Examples and Comparative Examples that the use of addition polymerizable<sup>1</sup> alkoxy-functional  $\alpha$ -silanes in functionalizing silica results in a surprising and unexpected increase in abrasion resistance. For example, methacrylomethyltrimethoxysilane (inventive, an  $\alpha$ -silane) was compared with methacrylopropyltrimethoxysilane (non-inventive; not an  $\alpha$ -silane). The only difference in these two molecules is the methylene spacer between the methacrylo group and silicon as opposed to

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<sup>1</sup> *i.e.* containing an unsaturated group

the propylene spacer in the compound preferred by *Fukushima*. A 24% increase in abrasion resistance was obtained, a very surprising, unexpected, and significant result, as indicated by the accompanying Rule 132 Declaration of Dr. Christoph Briehn. Since the molecules are otherwise similar, it is clear that the surprising and unexpected improvement is due to the use of the methylene-spaced  $\alpha$ -silane, not for some other reason. Thus, other alkoxy-functional  $\alpha$ -silanes would be expected to provide the same effect.

Even further surprising is that methacrylomethyldimethylmethoxysilane, with but a single methoxy group, was highly effective. In fact, Example 5, which used this  $\alpha$ -silane, showed the highest scratch resistance of all. Note that *Fukushima* did not disclose any monoalkoxysilane in his list of silanes in column 5, and with good reason. It is well known that the reactivity of alkoxysilanes increases as the number of alkoxy groups increases, due to the electron withdrawing nature of such groups as well as the fact that more alkoxy groups are available for reaction. Thus, for example, vinyltrimethoxysilane, one of *Fukushima's* preferred alkoxysilanes, is far more reactive than vinyl dimethylmethoxysilane. *Fukushima* did not mention any monoalkoxysilane (although they are within his broad formula), because he clearly knew that such silanes would be of doubtful use in functionalizing silica. Applicants' monoalkoxy- $\alpha$ -silanes, on the other hand, are very effective, and as mentioned previously, Example 5, using such an  $\alpha$ -silane, had the highest scratch resistance of any formulation tested.

It is clear both that *Fukushima* did not recognize the surprising and unexpected benefits of employing  $\alpha$ -silanes, but also that he did not direct the skilled artisan to these silanes. Of all the silanes within the formula of *Fukushima*, only those which are both acrylo- or methacrylo- functional and which contain an  $R^1$  methylene group are  $\alpha$ -silanes. None of the compounds where X is vinyl are  $\alpha$ -silanes, no matter what  $R^1$  is, and none of his acrylo- or methacrylo- functional silanes are  $\alpha$ -silanes when  $R^1$  is zero (covalent bond) or  $C_{2-8}$  alkylene. When isomers are considered, the number of non- $\alpha$ -silanes within *Fukushima's* broad formula is enormous indeed.

*Fukushima* does not require the "-A-" group of Applicants, and vinyltriethoxysilane and vinyltrimethoxy silanes, which contain no -A- group, are not  $\alpha$ -silanes. Nor are any of his other preferred silanes. In determining obviousness, the question is whether the prior art teaches or suggests the claimed invention. *Fukushima* does not do so. One skilled in the art, reading *Fukushima*, would choose one of *Fukushima's* preferred silanes. Silanes such as vinyltrimethoxysilane and methacrylopropyltrimethoxysilane are well known and readily available commercial silanes, available at reasonable cost. Why would one skilled in the art choose to use an alkoxy-functional  $\alpha$ -silane which is much more expensive, than one of *Fukushima's* preferred silanes? The answer is that one so skilled would not do this.

The rejection can also be viewed in the context of *KSR v. Teleflex*. *KSR* indicated that an invention may be obvious when there are but limited choices and the outcome is predictable, rather than surprising or unexpected. If either the choices are myriad or the outcome is not as predicted, the invention is non-obvious. That is the case here.

Fully one-third of all the compounds falling within *Fukushima's* formula are not  $\alpha$ -silanes (*i.e.* all those where X is vinyl). Of the remaining two-thirds, even ignoring isomers (of C<sub>3</sub>-C<sub>8</sub> alkylene R<sup>1</sup> groups, 89% (8 of 9) of these are not  $\alpha$ -silanes. The formula of *Fukushima* encompasses literally hundreds of possibilities (ignoring the OR<sup>3</sup> groups). Hundreds of possibilities, of which only a few are  $\alpha$ -silanes, is not a "limited number" of possibilities as required by *KSR*.

Moreover, the result achieved by Applicants is not the predicted or expected (*KSR*) result. The result of merely substituting a methylene group for *Fukushima's* preferred propylene group would be expected, based on similarity of structure, to produce functionalized silica particles whose use in coating formulations would result in coatings with scratch resistances similar to those of non- $\alpha$ -silanes. This is the "*KSR*" expected result. Surprisingly and unexpectedly, this did not occur. Rather, coatings with considerably and significantly increased scratch resistance were obtained. This was not the outcome one skilled in the art would have predicted.

In the Office Action, the Office dismissed the prior *Briehn* Declaration for two reasons. First, the Office alleges that the Declaration did not provide evidence of long felt need, and second, that the showing was not commensurate with the scope of the claims. Applicants respectfully disagree. Accompanying this response is a further Declaration from Dr. Briehn addressing these matters. However, the Office should itself be aware of the long felt need which is evidenced by the very reference used to reject the claims (*Fukushima*), and which is repeated in many, many patents and published applications since the publication of *Fukushima*. Dr. Briehn addresses this on pages 2 to 3 of his Declaration, in section 3. One skilled in the art is well aware that this has been a long standing and continuing problem, as anyone who has taken their car through a car wash can attest.<sup>2</sup>

Dr. Briehn also indicates that the results obtained by Applicants are surprising and unexpected, and are due to the presence of the methylene "spacer", *i.e.* to the use of addition polymerizable alkoxy-functional  $\alpha$ -silanes, as opposed to the numerous other silanes proposed and preferred by *Fukushima*. Dr. Briehn also indicates that based on his scientific experience (which is considerable),  $\alpha$ -silanes with a variety of "-C-D" groups and a variety of alkoxy groups would be expected, in light of the results obtained with the two  $\alpha$ -silanes used in the inventive examples, to also show significant increase in scratch resistance as compared to non- $\alpha$ -silanes with the same unsaturated groups and the same alkoxy groups. There is scientific basis for believing that other  $\alpha$ -silanes, which were not tested, would also produce surprising and unexpected results, and thus the results submitted, in the absence of evidence to the contrary<sup>3</sup>, indicate that Applicants showing is commensurate with the scope of the claims. It should be noted that even a single example/comparative example can support broad claims. Applicants should not be put to the burden of performing numerous, expensive examples and comparative

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<sup>2</sup> The Office also appears to assert, as understood by Applicants, that there must be evidence that those skilled in the art were aware of the *Fukushima* reference. However, this is incorrect. The skilled artisan is legally presumed to have knowledge of all of the art in the technological field.

<sup>3</sup> See, *e.g.* *In re Piasecki*, 223 USPQ 788 (Fed. Cir. 1984) for the shifting burdens of going forward as between the Office and the Applicants.



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examples when the ones submitted are evidence of the generality of the surprising and unexpected results obtained.


For all the reasons expressed above, withdrawal of the rejection under 35 U.S.C. § 103(a) over *Fukushima* is respectfully requested.

Applicants submit that the claims are now in condition for Allowance, and respectfully request a Notice to that effect. If the Examiner believes that further discussion will advance the prosecution of the Application, the Examiner is highly encouraged to telephone Applicants' attorney at the number given below.

Please charge any fees or credit any overpayments as a result of the filing of this paper to our Deposit Account No. 02-3978.

Respectfully submitted,

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